

ship from the Horace H. Rackham School of Graduate Studies at Ann Arbor, Michigan, for the purpose of investigating the bryophytes of the coast redwood forest, is gratefully acknowledged. Funds for travelling expenses contributed by the Botanical Gardens of the University of Michigan are deeply appreciated.

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REVIEWS

Plant Embryology. By DONALD ALEXANDER JOHANSEN. The Chronica Botanica Company, Waltham, Massachusetts. xviii + 305 pp., frontispiece, figures 1-80. 1950. \$6.00, regular memoir edition; \$14.00, special edition.

Because of the time-consuming nature of the work, American botanists for the most part have been unwilling to undertake monographic treatises in particular fields as was formerly done by many of the Europeans, especially the Germans. In the field of embryology the only work of such a nature has been the exhaustive survey, "Embryologie der Angiospermen" by the Austrian, Schnarf, which was published from 1927-29. Like the older workers and like many today, such as Maheshwari, Schnarf considered embryology in its broad meaning to include studies on mega- and microsporogenesis, mega- and microgametogenesis, and development of the structures of the ovule before and after fertilization, as well as study of the embryo. Since the publication of his work many additions to the literature on embryology have appeared. Therefore, Dr. Johansen's monumental work is especially welcome at this time, even though he has limited himself to what he considers embryology proper.

To Dr. Johansen plant embryology embraces embryonic morphology, embryonic physiology, and embryogeny. In the present work the treatment of embryological topics is restricted to the latter field with its divisions of embryogenesis, embryotectonics, embryogenergy, and embryonomy. He has attempted to make a correlation and evaluation of the

studies on embryogeny of the Spermatophyta appearing in publications over a period of more than a century. His literature citations include those appearing prior to 1947.

The history of both angiospermic and gymnospermic embryology is discussed in the introduction.

Slightly less than one third of the book is devoted to the Gymnosperms. Dr. Johansen maintains with Hagerup and others that the Gymnosperms do not constitute a natural group and has therefore separated them into phyla or divisions: Cycadophyta, Ginkgophyta, Coniferophyta, and Ephedrophyta. One chapter is devoted to each of the fifteen families attributed to these four divisions. For each family, fertilization, the proembryo, and the embryo are described and the Taxodiaceae and Cupressaceae are further divided into subfamilies for which these topics are discussed. There is a short treatment on the comparative embryogeny of the genera of the Pinaceae in the chapter dealing with that family. The work on Gymnosperms is profusely illustrated with original line drawings or those redrawn from other authors.

The Angiosperms are termed Anthophyta and are treated as a unit. They are not segregated into the customary taxonomic groups of Dicotyledons and Monocotyledons, because there is no embryological distinction between the two.

The embryology of the Anthophyta occupies about two-thirds of the book. Before taking up embryological Types and Variations, and the special and comparative embryology of the individual orders and families, a chapter on general considerations defines the subdivisions of embryology and formulates the fundamental laws of embryonomy. The explanation for the fundamental organization of the embryo of a given species is provided for by the embryonomic laws, which may be stated: (1) the Law of Parsimony, "no more cells are produced by the embryo than are absolutely necessary"; (2) the Law of Origin, "in any particular species, the sequences of cell formation may be established in such a manner that the origin of the cells may be defined in exact terms by referring to the one or to the other of the terms of the sequence"; (3) the Law of Numbers, "the number of cells produced by different cell generations varies with the species and depends on the rapidity of the segmentation in the cells of the same generation"; (4) the Law of Disposition, "in the course of normal embryonic development, the cells are constituted by divisions in clearly determined directions and appear to occupy positions in accordance with the role which they must play"; and (5) the Law of Destination, "the cells of the proembryo of a given species, when the development is normal, give rise to clearly determined parts, and always to the same parts, of the embryonic body."

In order to elucidate the laws of embryonomy, Dr. Johansen has had recourse to formulae based on those originally used by Soueges. When formulae are combined into a table of recapitulation it is clear that they define the number of cells, disposition of cells, and role played by the cells during embryo development. The formulae indicate the precise relationships which individual cells present to one another in the course of development of the embryo.

Six main types of embryonomy are recognized according to the operation of the embryonomic laws, and a key separating them is presented. The majority of accounts which have been described in the literature can be fitted into one or another of these types. Minor deviations from each type which have occurred during evolution are termed variations. Keys separating the variations under each type are also given.

The types of embryonomic development are those first established by Schnarf. He named the type after the family to which belonged the species whose embryonomy was most completely known. Johansen has taken the root of the family name and attached the Latin suffix *-ad*, and with one exception has retained the names of the families used by Schnarf. Thus the first type is designated the Piperad Type because this mode of development has been most completely described in *Peperomia pellucida*, a member of the Piperaceae. Variations from the type are designated by the name of the genus whose embryonomy departs in a minor fashion from the type, as the *Balanophora* Variation. It is evident that this method of designating types has no phylogenetic significance since many Anthophyta in widely separated orders may show the same type of embryonomy. Many botanists will criticize this as misleading and contend that a classification that has no phyletic import is worthless. However, a somewhat similar practice of naming types has long been in use in embryo sac studies, and has been found a convenient method of designating a given type of development. In such studies the type is named for the genus in which it is first described.

The classification of embryo types of Soueges, based only on those species which he himself had investigated, was unknown to Dr. Johansen at the time he started work on his own system. He has, however, now made a comparison of the two systems and discussed them at some length.

Over half of the book consists in the special and comparative embryology of members of the Anthophyta for which embryonomic data are known. The classification of Orders and Families is according to Hutchinson's "The Families of Flowering Plants," Vol. I and II. Each species is assigned to one of the six types with their variations and a

short discussion of each is included. There are numerous line drawings as in the chapters on Gymnosperms.

Three chapters at the close of the book deal respectively with apomictic embryogeny, adventitious embryogeny, and polyembryony. A glossary and indices follow. There is one index for orders and families and another for genera and species. Unfortunately there is no bibliography at the end of the entire book, literature citations being given only at the end of each chapter.

Although many will not agree with the classification that Dr. Johansen has set up, nevertheless it should act as a stimulus and point of departure for other classificatory schemes. The compilation of such a great amount of information on embryological literature between the covers of one volume is justification enough for the work. It will be of use not only to plant embryologists, but to other botanists such as cytologists, anatomists, morphologists, taxonomists, and those devoted to the study of evolution as well. Dr. Johansen is to be congratulated on furnishing them with such a wealth of information.

At present Dr. Johansen is undertaking to keep a record of species newly investigated with respect to their embryology. Because of poor library facilities he will include only those references obtained from reprints forwarded to him. Summaries will be presented from time to time in one of the regular botanical journals. Dr. Johansen can be reached at: 861 East Columbia Avenue, Pomona, California, U.S.A. He is also attempting to establish an International Commission for plant slide exchanges, and we take this opportunity to refer to this project. MARION S. CAVE, Department of Botany, University of California, Berkeley.

Manual of Phycology. An Introduction to the Algae and Their Biology. GILBERT M. SMITH, editor. The Chronica Botanica Company, Waltham, Massachusetts. xii+375 pp., 2 frontispieces, 48 figs. 1951. \$7.50.

The appearance of the *Manual of Phycology*, long awaited by contributors as well as interested bystanders, is an event of signal importance to this branch of biology. Although there are now a number of books which deal with the algae as a whole, the *Manual* is unique in two respects. First, it is a cooperative undertaking in which outstanding phycologists have contributed chapters treating those phases of the field in which they are specialists. Second, the space allotted to comparative morphology and classification has been reduced to about half the total text.

The cooperative nature of the *Manual* has its inherent advantages and disadvantages. The summation of the training, knowledge, and experience of the contributors permits